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FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET
Exhibit R-2

DATE: February 2008

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N
PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	94,652	41,204	37,058	59,356	70,747	87,384	92,171
2913 RF SYSTEMS ADVANCED TECHNOLOGY	42,908	22,325	37,058	59,356	70,747	87,384	92,171
9999 CONGRESSIONAL PLUS-UPS	51,744	18,879	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this PE address technologies critical to enabling the transformation of discrete functions to network centric warfare capabilities which simultaneously perform Radar, Electronic Warfare (EW), and Communications and Network functions across platforms through multiple, simultaneous and continuous communications/data links. The Radio Frequency (RF) Systems Advanced Technology program addresses RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, and Multi-Function sensor systems. The Program emphasizes near to mid-term transition opportunities by developing and demonstrating technologies supporting the Future Naval Capabilities (FNC) Program Enabling Capabilities (ECs) for Multi-Source Intelligence, Surveillance, and Reconnaissance (ISR) for the Warfighter, Long Range Detection and Tracking, Advanced Electronic Sensor Systems for Missile Defense,

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Marine and all types/forms of Unmanned Vehicles (UxV) Tactical ISR, Next Generation Airborne Electronic Attack, Advanced Communication for FORCENet, GIG-Compliant Networking, Low Cost Over the Horizon Communication, Satellite Communication (SATCOM) and Line of Sight (LOS) Apertures, and Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms. Within the Naval Transformational Roadmap, this investment offers affordable options for the transformational capabilities required by the Sea Shield (Theater Air and Missile Defense), Sea Strike (Persistent Intelligence, Surveillance, and Reconnaissance), and ForceNet (Communications and Networking) SeaPower 21 Naval Warfighting Pillars.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

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B. PROGRAM CHANGE SUMMARY:

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
FY 2008/FY 2009 President's Budget Submission	98,065	22,676	29,566
Congressional Action	0	19,000	0
Congressional Undistributed Reductions/Rescissions	0	-290	0
Execution Adjustments	-1,286	0	0
Federal Technology Transfer	-20	0	0
Program Adjustments	-85	0	7,613
Rate Adjustments	0	0	-121
SBIR Assessment	-2,022	-182	0
FY 2009 President's Budget Submission	94,652	41,204	37,058

PROGRAM CHANGE SUMMARY EXPLANATION:

Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:

Not applicable.

D. ACQUISITION STRATEGY:

Not applicable.

E. PERFORMANCE METRICS:

Advanced Electronic Sensor Systems for Missile Defense and Long Range Detection and Tracking ECs are aligned to the Navy's Advanced Cruiser (CG(X)) plans and closely coordinated with Naval Sea Systems Command Integrated Warfare Systems (PEO IWS 2.0). Multi-Source ISR to the Warfighter supports the Navy's Advanced Destroyer (DD(X)) Electronic Surveillance requirements and is closely coordinated with PEO IWS 2.0. Marine and UxV Tactical ISR supports Program Manager Aviation (PMA) 263 Broad Area Maritime Surveillance (BAMS) acquisition strategy. Advanced Communications for ForceNet is aligned with a number of acquisition programs ranging from

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undersea warfare to carriers. Other performance metrics are discussed within the R-2a.

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PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

PROJECT NUMBER: 2913

PROJECT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2913 RF SYSTEMS ADVANCED TECHNOLOGY	42,908	22,325	37,058	59,356	70,747	87,384	92,171

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The RF Systems Advanced Technology Thrust addresses technologies critical to enabling the affordable transformation of discrete functions to network centric warfare, utilizing multiple, simultaneous, and continuous communications/data links between platforms while simultaneously performing the functions of Radar and EW. Work in this thrust addresses cost-effective RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, and Multi-Function sensor systems. The thrust emphasizes near to mid-term transition opportunities by developing and demonstrating technologies which enable affordable options for transformational capabilities required by the Sea Shield, Sea Strike, and ForceNet pillars.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
ADVANCED MULTI-FUNCTION RF TECHNOLOGY	42,908	22,325	37,058

This effort develops, demonstrates, and transitions affordable wideband, high performance Advanced Multifunction Radio Frequency (AMRF) apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams while providing reduced signature and numbers of apertures. Program activity goals include development and demonstration of multi functional RF technologies applicable to systems development for Advanced Destroyers (DD(X)), Advanced Cruisers (CG(X)), Aircraft Carriers (CVNs), and other ship classes. These technologies will provide reduced recurring costs for total system functionality; reduced number of topside antennas and support systems; reduced ship radar cross section; reduced number of unique spares and lower ship manning requirements; ability to upgrade systems and capabilities with reduced cost, time, and complexity while mitigating the risk of obsolescence; and ability to rapidly exploit technological innovation through open systems concepts. This activity also includes Multifunction Systems Technology developments that directly support the Department of Defense Joint Warfighter Science and Technology Plan and the Defense

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Technology Area Plans.

Major objectives include:

Affordable, open architecture Digital Array Radar for CG(X). Development, testing, and technology demonstration of communications, electronic attack, electronic surveillance, and radar functions in multi-function apertures. Development of a Multi Function Electronic Warfare/Electronic Surveillance (MFEW/ES) Advanced Development Model (ADM) architecture demonstrating key ES capabilities for several simultaneous ES functions and capable of supporting additional RF functions. Conducting MFEW/ES ADM testing that satisfies DD(X) acquisition program Technology Development (TD) phase requirements to enable a smooth transition of AMRF technology to the DD(X) System Development and Demonstration (SDD) Acquisition Phase with minimal changes in system architecture. Electronic Attack (EA) Techniques maintain effective countermeasures in the face of increasingly sophisticated naval threats.

Budget decrease from FY 2007 to FY 2008 is due to completion of the following efforts:

-MFEW/ES FNC effort.

-Digital Array Radar Prototype Components FNC effort.

-EA Techniques to Counter Advanced Threats FNC effort.

The increase from FY 2008 to FY 2009 is due to Future Naval Capability (FNC) zero-sum program of record update and initiation of Integrated Digital Apertures and Array Radar System (IDAARS) Innovative Naval Prototype effort.

FY 2007 Accomplishments:

- Continued operation of the wideband multi-function Communications and EW testbed in support of multi-function system development and multi-function technology insertion and demonstration for the AMRF-C effort.
- Continued Shipboard Electro-Optical/Infra-Red (EO/IR) Closed Loop Self-Protection effort.
- Continued development of a High Band array antenna capable of simultaneously supporting multiple Electronic Support Measures (ESM) surveillance functions for the MFEW/ES ADM, providing 4 high gain high sensitivity Electronics Support Measures beams.
- Continued development of a Mid Band array antenna capable of simultaneously supporting multiple ESM functions for the MFEW/ES ADM.
- Continued development of back-end analog receiver equipment supporting MFEW/ES ADM.

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- Continued systems integration, risk reduction, and Navy critical subsystem development effort leading to demonstration of MFEW/ES ADM in a relevant environment and support MFEW/ES hardware/component testing within the AMRF-C testbed.
- Completed the MFEW/ES Program Technology Development Phase, demonstrating complete systems integration, risk reduction, and Navy critical subsystem development leading to demonstration of MFEW/ES ADM in a relevant environment, and continued to support MFEW/ES hardware/component testing within the AMRF-C testbed.
- Completed development of S-band Digital Array Radar prototype components development.
- Completed the EA Techniques to Counter Advanced Threats effort by conducting field testing of the Coherent EA Advanced Techniques Generator (ATG) and Digital Radio Frequency Memory (DRFM) Hardware containing a field programmable gate array (FPGA) development board that is capable of operating at 200 MHz.
- Initiated Shipboard EW Improvement and EA Transmitter projects to develop Electronic Warfare/Electronic Attack capability for rapid technology insertion into DD(X) and other ship classes utilizing MFEW/ES ADM components and architecture and AMRF-C testbed technology. Demonstrated capability to support 4 beams/band transmit functions.
- Initiated final at-sea demonstration of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the Shipboard EO/IR Closed Loop Self-Protection effort by final at-sea demonstration of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware which includes a Mid-Wave IR (MWIR) camera operating in the 2-5 um wavelength spectral band.
- Initiate FNC EC Long Range Detection and Tracking. Capture and extend the prototype development that occurred under Advanced Electronic Sensor Systems for Missile Defense, this project delivers an affordable, open-architecture Digital Array Radar (DAR) single face Advanced Development Model.
- Initiate the Next Generation Airborne Electronic Attack effort by performing a threat assessment study.
- Initiate FNC EC Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms. Develop Partial Array consisting of high efficiency non-commercial off-the-shelf (COTS) transmitter element chains using wide band-gap semiconductors, mixed signal digital, RF, microwave, millimeter wave and associated passive components, exploiting Development & Implementation (D&I) advances in high power, high efficiency digital S- and X-band microwave amplifiers to reduce cooling and prime power needs, enabling affordable radar and EA solutions for CG(X) and DD(X). Develop and demonstrate the technology for extending the digital domain further into the transmitter RF hardware, i.e., bringing the digital domain closer to the radiating element,

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enabling Navy systems to continue to exploit advancements in COTS computing capacity for signal generation and processing, and require the activity to only develop the combined RF/digital hardware. Target cost reductions to enable ubiquitous deployment of advanced radiating systems with affordable development and procurement costs. This EC will take the lead for development of efficient, high power RF digital-microwave transmitter technology by exploiting new technologies such as Wide Band Gap (WBG) semiconductors for substantial savings of prime power requirements and topside weight and moment. This will provide a potential for smaller ships and reduced acquisition and life cycle costs.

- Initiate H-60 Tactical Commercial Data Link (TCDL) project.
- Initiate Low cost SATCOM-on-the Move array for Marine Corps.
- Initiate nested, coplanar array/ Modular Integrated Link Electronics System (MILES) design and integration.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete FNC EC: Long Range Detection and Tracking, S-Band Digital Array Radar Advanced Development Model.
- Initiate Integrated Digital Apertures and Array Radar System (IDAARS), a multi-function RF topside aperture prototype covering approximately 200MHz to 22 GHz and provide the appropriate control and synergy of the functionality such that the RF functions automatically support one another providing improved operational capability. Additionally, demonstrate reductions in size, weight, and power as well as cost (both acquisition and life cycle) by reducing the number of topside apertures needed for communication, electronic warfare, and some radar functions. A critical tenet of the prototype will be the demonstration of an open architecture so that not only can different companies supply the major components such as a given receive or transmit aperture, but even down to the subarray and lower component level throughout the life cycle to ensure continuing competition for maintenance and replacement parts.
- Initiate the Enhanced Nulka Payload FNC effort by starting system architecture design.
- Initiate the Enhanced Surface Electronic Warfare Improvement Program (SEWIP) Transmitter FNC effort by starting system architecture design and Low Voltage Gallium Arsenide (GaAs) High Power Amplifier (HPA) Monolithic Microwave Integrated Circuit (MMIC) purchases.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:

PE 0204152N E-2 Squadrons

PE 0601153N Defense Research Sciences

PE 0602123N Force Protection Applied Research

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PE 0602131M Marine Corps Landing Force Technology

PE 0602235N Common Picture Applied Research

PE 0602271N RF Systems Applied Research

PE 0603123N Force Protection Advanced Technology

PE 0603235N Common Picture Advanced Technology

PE 0603640M USMC Advanced Technology Demonstration (ATD)

PE 0604307N Surface Combatant Combat System Engineering

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:

Not applicable.

D. ACQUISITION STRATEGY:

Not applicable.

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PROJECT NUMBER: 9999

PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED LOW COST RADAR MODULE COOLING SYSTEM	1,311	0

ONR sponsored research to perform risk reduction on affordable methods to cool microwave power amplifiers. This technology will provide cost savings and performance enhancement to large phased array radars.

	FY 2007	FY 2008
ADVANCED WIDEBAND OPEN ARCHITECTURE RADAR SYSTEM	11,654	0

ONR sponsored the development of architecture and components for a wideband radar compatible with airborne platforms. The effort addressed the Navy's requirement for a future long range Airborne Electronic Warning radar that includes the capability to classify targets, conduct feature aided tracking, operate with jamming and restricted frequency spectrums.

	FY 2007	FY 2008
APY-6 REAL TIME PRECISION TARGETING RADAR	1,942	0

Deliverables included flight testing, mode development and integration support.

	FY 2007	FY 2008
C-BAND ACTIVE ARRAY RADAR (CBAAR)	15,993	3,973

FY 2007: The deliverable was the C-BAAR System Design Studies.

FY 2008: The deliverable will be the C-BAAR System Design and the Phased Array Technology Demo Study.

	FY 2007	FY 2008
COMMAND AND CONTROL ON THE MOVE NETWORK DIGITAL OVER THE HORIZON	6,376	0

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PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
RELAY (CONDOR)		

ONR sponsored research of a mobile Command and Control over the horizon system.

	FY 2007	FY 2008
COMMON AFFORDABLE RADAR PROCESSOR	2,816	0

Deliverables included 12 channel data distribution module and end to end system test.

	FY 2007	FY 2008
COMMON RADAR SIGNAL PROCESSOR	6,603	0

ONR sponsored research to develop a Common Radar Signal Processor. This technology will allow cost savings and performance enhancements to large phased array radars.

	FY 2007	FY 2008
HORIZON EXTENSION SURVEILLANCE SYSTEMS (HESS)	1,456	0

Deliverables included Miniature Microwave Integrated Circuit (MMIC) with integrated transmit/receive switch.

	FY 2007	FY 2008
JOINT ELECTRONIC ATTACK UNMANNED VEHICLES	971	0

Deliverables included an electronic attack (EA) payload installed in a pod that is certified for flight onboard Predator-class unmanned aircraft such as Predator A and B, Improved-Gnat (iGnat) and Warrior; and a ground station which includes all software and communications equipment necessary to monitor and control the payload.

	FY 2007	FY 2008
OPEN ARCHITECTURE COMPUTER TEST BED	1,554	0

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PROJECT TITLE: CONGRESSIONAL PLUS-UPS

ONR sponsored research in Open Architecture fusion and display technologies in support of Netcentric operations.

	FY 2007	FY 2008
PACIFIC AIRBORNE SURVEILLANCE AND TESTING	0	14,906

ONR will sponsor the development of component prototypes to enable multi-band/ multi-function capabilities compatible with airborne platforms.

	FY 2007	FY 2008
POLYIMIDE MACRO ELECTROMECHANICAL SYSTEMS	1,068	0

Deliverables included K-Band receive array for wideband global satellite data.